

Boosting Retail Efficiency: AI-Powered Checkout Cuts Costs & Queues by 80%

The client, a regional retail chain with over 50 convenience stores, marts, and gas station outlets, serves a diverse customer base in urban and semi-urban areas. With a focus on providing quick and convenient shopping experiences, the client faced growing operational challenges due to inefficient billing processes. Long checkout queues, particularly during peak hours, led to customer dissatisfaction and strained resources, prompting the need for a transformative solution to modernize their operations and enhance customer experience.



What the Client Needed

The goal was to design and implement an innovative, AI-driven solution to automate the billing process, addressing the following objectives:

Eliminate long checkout queues to improve customer satisfaction.

Reduce dependency on manual labor to lower operational costs.

Maintain high accuracy in product identification and billing to minimize errors and enhance trust.

Accelerate the billing process to handle higher transaction volumes efficiently.

Ensure scalability for deployment across various store formats, including marts, small stores, and gas station convenience outlets.

Tech Stack

- PyTorch 1.12** for model training and deployment, with **TorchScript** for optimized edge deployment.
- OpenCV 4.5** for image preprocessing and **YOLOv7** for state-of-the-art object detection performance.
- Roboflow** for efficient dataset creation and management.
- stripe** **Stripe API v3** for secure, automated payment processing.
- NVIDIA Jetson Nano** for real-time inference at the store level.
- DeepSORT** (Deep Simple Online and Realtime Tracking) to track customers across multiple cameras.
- aws** **AWS** (for model hosting) for scalable deployment and data storage.



Key Business Challenges

The client faced several operational and customer-facing challenges that necessitated a technological overhaul:

- Extended Checkout Times**
Peak-hour queues resulted in average wait times of 10-15 minutes, leading to
- High Labor Costs**
The need for additional cashiers and support staff during busy periods increased
- Error-Prone Billing**
Manual scanning led to frequent billing errors, requiring additional staff time for corrections and impacting customer
- Scalability Constraints**
The existing system was not adaptable for smaller store formats or gas station outlets, limiting the client's expansion strategy.
- Customer Retention Risks**
Slow and cumbersome checkout processes negatively affected customer loyalty, with a reported 20% drop in repeat visits during peak seasons.

What We Delivered

The team engineered a state-of-the-art autonomous checkout system leveraging computer vision, real-time data processing, and AI-powered object detection

- Automated Item Recognition**
 - Deployed YOLOv7-tiny models on edge devices to detect and classify products in real time with 99% accuracy across 1,500 unique SKUs.
 - Implemented multi-object tracking to associate products with individual customers
- Real-Time Computer Vision Integration**
 - High-resolution IP cameras paired with NVIDIA Jetson Nano edge devices.
 - Computer Vision Framework was built using OpenCV and accelerated with CUDA libraries on Jetson for low-latency processing.
- Facial Recognition for Customer Identification**
 - Implemented Dlib with facial embeddings and OpenCV for real-time recognition.
 - Each customer is authenticated through the mobile app and recognized in-store via facial recognition.
- Dynamic Cart Generation and Mobile App Integration**
 - Leveraged Flutter for front-end and Node.js and Express.js for backend to build a cross-platform mobile app.
 - The app receives real-time updates from edge devices via WebSockets for instantaneous cart changes.
- Frictionless Payment System**
 - Leveraged Stripe API for secure, one-tap payments via the mobile app.
 - Implemented auto-checkout functionality, allowing payments to process automatically
- System Monitoring and DevOps**
 - Utilized Prometheus for real-time monitoring of system performance and Grafana for dashboard visualization.
 - Configured using GitHub Actions to automate code testing, container builds (Docker), and deployment to AWS.

Business Impact

- Reduced Wait Times**
Checkout duration dropped up to 70%, from several minutes to mere seconds, significantly improving customer throughput.
- Enhanced Customer Experience**
Shoppers enjoyed a seamless, frictionless checkout, leading to higher satisfaction and increased store loyalty.
- Scalability**
The modular architecture allowed easy deployment across various store formats, supporting both large and small retail environments.
- Lower Operational Costs**
Automation reduced the need for multiple cashiers, enabling resource reallocation and cost savings.
- Improved Accuracy**
Automated item recognition and weight validation minimized human errors, ensuring precise billing and inventory management.
- Data Insights**
The system collected granular data on sales, popular items, and customer preferences, enabling data-driven business decisions and targeted marketing.

Conclusion

This project marks a paradigm shift in retail operations by leveraging artificial intelligence and computer vision. The solution not only optimized the billing process but also enhanced customer satisfaction and reduced operational burdens. By investing in next-generation retail technology, the client has positioned themselves as an industry innovator, ready to scale and lead in the era of smart retail.